

operation between obstetrician and anesthetist in order to obtain the best results.

The writer has implied the necessity of a skilled anesthetist in obstetrical analgesia and anesthesia. This point, also, cannot be stressed too greatly, as at any time in the course of delivery conditions may arise that endanger two lives, and the anesthetist should not be forced to ask the help of the obstetrician. Most experienced anesthetists have known of tragic results due to the rather prevalent idea that almost anyone can give an obstetrical anesthetic.

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H. A. STEPHENSON, M.D. (490 Post Street, San Francisco).—Doctor Wright has covered the subject well and understandingly. I have had no experience with avertin and cyclopropane. Of the others, I feel that, in selected cases, paraldehyd, followed by morphin, nitrous oxid and oxygen have given best results. The analgesia is usually quite satisfactory, and the amount and duration of anesthetic required in the second stage are reduced considerably. The recovery of such patients seems to me to be somewhat more rapid than in patients not receiving this combination of drugs. No ill effects on mother or baby have been observed after its use.

Doctor Wright mentions briefly the barbiturates. These have received great attention lately, and have been extensively employed. My experience with them leads me to the conclusion that they possess no advantage over the paraldehyd.

I wish to strongly emphasize the point brought out regarding the necessity of good teamwork and coöperation on the part of anesthetist and obstetrician.

TESTS FOR VASOMOTOR CONTROL

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AN abundance of literature has been accumulating on the subject of peripheral circulatory disorders. Numerous measures, complicated for the most part, have been advocated as a means of distinguishing between vasomotor spasm and obliterative arterial disease. To the general reader, the data offered is often confusing, or its scope of application narrowed to a few clinics specializing in the study of such disturbances. There are, however, several simple tests requiring no elaborate apparatus which may be utilized in the office.

The basic principle of the majority of the procedures, to be briefly described below, is to produce, directly or reflexly, a state of vasodilatation of the peripheral vessels. An important prerequisite in every instance is that the environmental temperature, where the test is being conducted, be in the range of 18 Centigrade to 22 Centigrade, in order to obtain a preliminary low-basal level as a measure of comparison after vasodilatation.

Thrombo-angiitis obliterans and Raynaud's syndrome are the two peripheral circulatory diseases of chief concern, due to the relatively high incidence of both afflictions; the difficulties encountered in arriving at a definite diagnosis; and the rapid strides made by the neurosurgeons, in recent years, to alleviate the pain and limitation of activity, particularly in the case of the former. Sympathectomy is usually unsuccessful in Raynaud's phenomenon, because the disturbance is

due to a local fault of the vessels, which, while not definitely known, is regarded as a functional one, an overaction to the cold stimulus.

INDIRECT OBSERVATIONS OF THE PERIPHERAL VESSELS

1. *Peripheral Pulse*.—In addition to the radial pulse which is usually palpated, the dorsalis pedis, posterior tibial, popliteal and femoral arteries are easily accessible. Absence of pulsations in one of these principal vessels is significant. It is well to remember that the dorsalis pedis is absent in four per cent of cases, and that in another eight per cent the artery is in a lateral position. The pedal pulses are frequently found to be absent in older male patients, who usually have no complaints. The slow gradual occlusion of the main vessels has permitted the development of an adequate collateral circulation.

2. *Postural Color Changes*.—Pallor on elevation of the part accentuated by rapid dorsal and ventral flexion, and rubor in the dependent position are signs of diminished blood flow. At a certain level, usually below the horizontal position, the pallor changes to the normal skin color without showing the reddish hue of capillary stagnation.

3. *Blood Pressure Determination*.—The ordinary sphygmomanometer can be readily employed to measure the difference in blood pressure on the two sides, both upper and lower extremities. The patient should be in the supine position and relaxed as much as possible.

4. *Cutaneous Histamin Reaction*.—See paper by Dr. Eric Ogden on this subject (Histamin and Adrenalin Tests).

5. *The Plethysmograph*.—Blood-volume changes in the digits or the extremities can be determined by the aid of this instrument. An airtight capsule to which is attached a finely-drawn pipette, containing a small amount of a colored indicator, is fitted snugly to the part to be examined. Photographic records are taken of the oscillations of the liquid indicator. The extent of excursion of the pulse is probably the result of the same factors which maintain blood pressure, in addition to the resistance of the soft tissues of the part in question. The deflection obtained is dependent upon the ability of the vessels to dilate with each heart beat and, in this sense, is a measure of vascular dilatation of the part. This pulse volume deviates sharply, in size and contour, in patients suffering from occlusive diseases of the arteries.

6. *Reactive Hyperemia*.—This phenomenon displays itself in a bright flush of the skin associated with an increased volume of the pulse on releasing the obstruction to the circulation. It was first intensively studied by Bier and has been further investigated by Lewis and Grant. Reactive hyperemia produces active dilatation of superficial terminal arterioles and outermost arteriolar plexuses, as well as deep vessels of an extremity. It is believed to be due to the accumulation of slowly diffusible products of metabolism in the extravascular spaces during the period of circulatory disturbance.

This test, therefore, can be employed to determine the patency of peripheral vessels in an extremity, under control conditions.

A blood pressure cuff is applied to the upper part of the extremity to be studied. The pressure in the cuff is raised abruptly to 300 or 350 millimeters of mercury. Time of occlusion varies from five seconds to fifteen minutes, average five minutes. The reaction is greater in a limb, the temperature of which has been raised to 30 to 35 Centigrade, but has no effect on its duration. Hyperemic flushing lasts from one-half to three-quarters as long as the occlusion is maintained. It reaches its height within twenty to thirty seconds and then fades away more gradually; the fraction is smaller when occlusions are very prolonged.

Visual observation, while simple, is quite inaccurate, since heat tends to produce reddening of the skin. Volumetric measurements using a water plethysmograph are more satisfactory and, in addition, the rate at which blood is entering the arm, under given condition, can be ascertained.

DIRECT OBSERVATIONS OF THE PERIPHERAL VESSELS

1. *Skin Temperature.*—The skin temperature of a given extremity depends upon the temperature and humidity of the examining room and body temperature. If these factors are fairly well controlled, room temperature 22 Centigrade, the patient resting and the oral temperature is normal, then thermal changes of the skin are chiefly dependent upon the blood flow. A flat-bulbed mercury skin thermometer is suitable for such determinations.

The value of skin temperature readings, obtained in this manner, is limited to : (1) a sudden drop in the temperature of one extremity indicates inadequate arterial flow; (2) marked differences between symmetrical areas on two extremities; and (3) a rise in temperature after employing various measures designed to relieve vessel spasm, which indicates a spastic element in the vascular occlusion.

2. *Tobacco-Smoking Test.*—Wright and Moffat found that surface temperature dropped markedly following the inhaling of cigarette smoke. This reduction in temperature is believed to be due to the absorption of minute quantities of nicotine. It is a manifestation of the response of the sympathetic nervous system to mild stimulation.

The subject was seated with his hands at the heart level, controlled room temperature and preliminary surface temperature readings taken. The cigarette was suspended by a reed before the patient who was permitted to smoke according to his usual custom. Temperature readings were recorded during and after the period of smoking. Cigarettes and denicotinized ones in addition to "filter paper" cigarettes were utilized in the experiment.

Each type of cigarette, except the "filter paper" cigarette, produced a drop in surface temperature as much as 10 to 15 Fahrenheit, the average being

5.3 Fahrenheit. The change in temperature may not occur with the smoking of every cigarette, but will be noted at some time during the course of a series of cigarettes smoked.

Lampson measured the rate of peripheral blood flow by accurately determining the rate of increase in the hand volume following occlusion of venous return at the wrist. The apparatus employed was a water plethysmograph. No smoking was permitted for three hours before the experiment.

The subject lay on his back, fully clothed and covered with a thin woolen blanket, with the right hand in the apparatus, under controlled conditions. The water-bath temperature varied between 30 to 33 Centigrade. The first half hour was devoted to determine the normal rate of blood flow; the patient then smoked, and records were taken during and after the period of smoking. The results were as follows: (1) inhaling of tobacco smoke—sudden drop in the rate of peripheral blood flow during the period of smoking, and at the end of forty minutes the flow was still partially depressed. Rise in blood pressure of 10 to 20 millimeters of mercury; pulse rate accelerated from six to twenty beats per minute; (2) non-inhaling-vasoconstrictor response which lasted only fifteen minutes. Changes in heart rate and blood pressure were insignificant; (3) denicotinized cigarettes—no vasoconstrictor response. The inhalation of a second cigarette induced slight reduction in the rate of blood flow, which returned to normal in fifteen minutes. Pulse rate and blood pressure remained constant; (4) pipe-smoking showed moderate reduction in blood flow during the act of puffing. No change in heart rate or blood pressure. If smoke were inhaled, sudden vasoconstriction occurred; (5) cigar smoking—30 per cent reduction in blood flow; 75 per cent reduction after moderate inhaling.

Blood-flow rate of reduction was greatest immediately after smoking. The degree and duration of vasoconstriction could be correlated to the amount of nicotine absorbed. Inhaling of tobacco smoke at least halved the rate of peripheral blood flow and caused it to remain partially depressed for about an hour. If smoke is not inhaled, the vasoconstrictor response is almost as great, but the reaction persists for only fifteen minutes.

3. *Overcooling.*—This procedure is utilized in studying Reynaud's syndrome of the upper extremities. Since excessive cold induces an after-reaction in the skin, tending to dilate the arterioles, this test effectively determines the degree and extent of involvement of the vessels, and suggests an appropriate course of therapy, vessel re-education.

The more affected digit of one hand and the corresponding digit of the other are immersed in cooled water, at or near 0 Centigrade for ten minutes. The digits are withdrawn, gently wiped dry, and skin temperature readings are taken at five-minute intervals. The height of reaction occurs in about twenty minutes and continues for an hour or

more. The neighboring digits act as controls during the test. In mild cases of the disease, the reaction of warmth of the immersed fingers will be observed to spread to the immediately adjacent digits, but in the more advanced stages little or no reaction is noted, reddening of the skin indicating only mild vasodilatation.

4. *Cold Stimulation Test.*—Hines and Brown devised this procedure as a possible means of detecting a prehypertensive state in patients who later in life develop essential hypertension. In subjects with essential hypertension vasomotor centers react excessively to stimuli which in normal individuals produce a minimal response. If hyperreactability in this disease is due to a biologic constitutional defect, its existence should be demonstrable in early life. It is of indefinite value if therapeutic measures to control vasomotor irritability are to be instituted before actual signs of disease appear.

The subject is placed in a recumbent position for fifteen minutes or until the blood pressure has approximated the basal level. With the blood pressure cuff placed on one arm, the opposite hand is placed in cooled water (4 to 5 Centigrade); the blood pressure is taken at the end of thirty seconds and again at the end of sixty seconds. The hand is removed from the water and readings are taken every two minutes until the blood pressure returns to the initial basal level. The highest reading obtained is recorded as a measure of the response. Usually the blood pressure returns to the basal level in two minutes after removal of the hand from water. This reaction is independent of any significant changes in the pulse rate.

Results: (1) normal group—average response for blood pressure, 8.8 millimeters and 7.93 millimeters of mercury systolic and diastolic, respectively. Range varied from 5 to 15 millimeters and 5 to 12 millimeters of mercury systolic and diastolic, respectively; (2) hypertensive group—young adults included—average values for blood pressure 34.5 millimeters and 23.2 millimeters of mercury systolic and diastolic, respectively. The range varied from 20 to 90 millimeters and 15 to 65 millimeters of mercury systolic and diastolic, respectively. The basis for the reaction is regarded as being purely a neurogenic reflex response to cold.

5. *Immersion of Forearms in Warmed Water.* This method, suggested by Gibbon and Landis, produces reflex dilatation of vessels of the lower extremities.

Both forearms are immersed for twenty minutes in warmed water, maintained at a temperature of 43 to 45 Centigrade by means of an electric heating coil. Skin temperature readings are taken at regular intervals from the time of immersion. Temperature rise in the toes will be observed in about fifteen minutes, normal vasodilatation level (32 Centigrade) being reached in thirty minutes. In defective peripheral circulation a rise in skin temperature reaching or exceeding the normal vasodilatation level definitely excludes obliterative structural disease, demonstrating an

adequate vascular bed to overcome the organic obstruction.

6. *Blanket Method of Collier and Maddock.*—The subject is covered with a light rubber sheet to the clavicular line and wrapped in three woolen blankets. With the high environmental temperature attained in this manner, the physical regulation of the body temperature results in maximal dilatation of the peripheral vessels.

Skin temperature readings are taken at the end of one hour. If the level of normal vasodilatation is not reached in this period, it is indicative of organic vascular occlusion.

7. *Induction of Artificial Fever.*—Lederle triple typhoid vaccine, five to twenty-five million killed organisms, injected intravenously. Mouth and skin temperature readings recorded every half hour over a period of three to five hours.

The following factors are thus obtained: (1) vasomotor index, the quotient of the rise in surface temperature divided by the rise in mouth temperature. A vasomotor index of two or more indicates an abnormal degree of vasoconstriction; (2) vasomotor range—rise in surface temperature of the affected digits from basal to maximum levels with fever. A high degree of vasoconstriction is considered to be present if this increase is 4 Centigrade or more; (3) maximum vasodilatation level—the highest temperature obtained in the affected digits. A level of 31.5 Centigrade or more indicates an adequate degree of vasodilatation of the digits in question.

In all of the foregoing factors, the rise in temperature of the mouth is deducted from the rise in surface temperature, so as to eliminate the actual increase in the temperature of the blood.

8. *The Oscillometer.*—Boultite modification of the Paschon oscillometer. The apparatus consists of two overlapping distensible pouches, having a combined width of 15 centimeters, enclosed in a rigid web cover fitted with straps. The instrument is strapped snugly to the extremity to be studied. By a simple valve arrangement, the pouches can be inflated singly or together. A manometric dial records the oscillometric variations at different pressures. Air is pumped in until the pressure is great enough to prevent any movement of the oscillatory needle. By means of a needle valve, the pressure is reduced 10 millimeters at a time. Eight separate readings are taken of each extremity studied.

Normal values are recorded as follows: Upper extremities—rise begins at 120 millimeters of mercury and drops to zero between 40 to 30 millimeters of mercury. Maximal oscillometric phase occurs between 100 to 80 millimeters of mercury. Lower extremities—rise begins at 160 millimeters of mercury and drops to zero around 40 millimeters of mercury. Maximal oscillometric phase occurs somewhat above 100 millimeters of mercury. In obliterative vascular disease, oscillations occur over a much narrower range of pressure.

It is possible, by means of this apparatus, to determine the level of vascular obstruction, the intensity of myocardial contractions and the elasticity of the vessel walls.

9. *Spinal Anesthesia*.—Morton and Scott found that if the sympathetic fibers innervating the blood vessels of the lower extremities were completely paralyzed, under temperature-controlled conditions, vasomotor spasm could be differentiated from organic obstruction.

Procain Hydrochlorid 0.100 to 0.120 gram is dissolved in a small amount of spinal fluid and rapidly injected intraspinally. Skin temperature measurements are taken at five or ten-minute intervals, as well as the pulse rate and blood pressure.

Three types of reaction are recorded: (1) no change in gradient, pointing to entire absence of vasospasm; (2) complete obliteration of the gradient, indicating that the peripheral disturbance is due entirely to vasomotor spasm; and (3) partial obliteration of the gradient, the peripheral surface temperature definitely elevated, but not reaching the normal vasodilatation level, demonstrating a mixture of vasospasm and obliterative processes.

Exceptions to the above for normal vessel response are found in patients with fever, or in those suffering from advanced carcinoma.

The normal vasodilatation-level has been fixed by the authors at 33 Centigrade. To estimate the element of organic obstruction in vascular disease, the maximum surface temperature reached after sympathetic paralysis is subtracted from this figure, this difference being termed the obstruction index.

Similar information, while not as complete or as accurate, may be secured by peripheral nerve block or paravertebral ganglion anesthesia.

10. *Arteriography*.—One of the measures outlined above usually suffices to differentiate between spasm and obliteration of the peripheral vessels, but there remains a comparatively small group of cases in which visualization of the peripheral arterial tree is extremely important as a diagnostic aid. Arteriography furnishes definite and useful information regarding the extent of the disease, the nature of the pathologic process and the physiologic compensation for the diminished flow of arterial blood as a result of occlusion of the main arterial passages.

Thorotrast, an opaque slightly radioactive substance, is utilized for this purpose. It is composed, by weight, of 19 to 20 per cent thorium oxid, and 16 to 19 per cent of a protective colloid. When introduced into the arterial circulation, it is engulfed by the reticulo-endothelial cells and very slowly excreted. The effects of its prolonged deposition within the body are, as yet, largely unknown.

The drug is injected in amounts varying from five to twenty cubic centimeters, depending upon the size of the subject and the area to be visualized, directly into the brachial or femoral arteries. Pressure is made and maintained above the site of injection, while a series of rapid x-ray exposures are made.

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HYPERTENSION: ITS SURGICAL APPROACH

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INTRODUCTION: Operative results in over two hundred cases of hypertension were reported by various surgeons* at the recent meeting of the American College of Surgeons in San Francisco. In a small percentage of these hypertensive cases, the blood pressure has been maintained at a normal level for periods of from several months to two years after operation. These investigators also observed a definite amelioration of symptoms and an appreciable drop in blood pressure in over one-half of the operated cases. Such encouraging results, in a condition that has previously failed to respond to any medical measures, cannot be ignored. Every member of the medical profession should know of the recent progress in this field.

OUTLINE

It is the purpose of this paper, first, to restate the known physiologic and pathologic changes that accompany essential hypertension. Second, to review the fundamental structure and function of the sympathetic and adrenal systems, and to point out their probable influence upon blood pressure. Third, to describe briefly the operative procedures now in use, and attempt to evaluate them. Finally, to propose a more extensive operation, based upon our present anatomic and physiologic knowledge plus the experience gained from previous operations done upon the sympathetic and adrenal systems.

DEFINITION

Both pioneers and present workers in this field have been handicapped because the etiology of essential hypertension is unknown. In describing the condition, Sir William Osler stated: "The exact cause of this high tension is unknown. Some have attributed it to overactivity of the adrenals, but it is much more likely that the primary difficulty is somewhere in the capillary bed—in that short space where the real business of life is transacted." Osler described this condition as simple high tension without signs of arterial or renal disease, and favored Clifford Allbutt's term "hyperpiesa." The condition is well known to be a progressive disease, often occurring in young people. It is characterized in the majority of cases in its early stages by periods of excessive rise in blood pressure without other evidences of pathologic change or disease, and is commonly termed "primary" or "essential" hypertension.

The pathologic changes in the kidney, heart, and blood vessels that result from hypertension have been described. The symptoms due to hypertension are well known. Internists can forecast the probable outcome in a series of cases with a fair degree of accuracy; yet this ability to describe the phenomena related to hypertension affords no

* References will be given in the reprints.